inch to an inch and a half in diameter in the middle, gradually sloping toward each end. There were also tubes of serpentine six or eight inches long, large chert knives, spear-points, and other things, all buried about four feet deep. Between this spot and the ocean was another burial-place, where, on the side of a declivity, many skeletons were found but eighteen inches to two feet below the surface, mingled with broken sandstone mortars and pestles, spear-points, arrow-heads, etc.

On the east side of the creek, between a high precipitous bluff and the ocean, is a three-cornered tract containing about ten acres, which is the site of an old rancheria or village. In the midst of this old town site I found a burial-place that indicated a somewhat more recent race than the first two mentioned. Here I exhumed a hundred or more skeletons, and at least a ton of relics: consisting of mortars and pestles of sandstone, ollas and tortilla stones of crystallized talc, pipes and bowls of serpentine, spear-points and arrow-heads of chert; also beads and 'charms,' and innumerable shell ornaments.

Last month I again visited this place, and exhumed a few more relics. In a spot about four by eight feet, and in the shape of a parallelogram, I found fifteen skeletons. With one of these were three tubes about three inches in length. In shape they were similar to the 'sinkers' already described, but with raised beads in the middle and at each end. These and some round beads were manufactured from serpentine. Beside the specimens mentioned, were many small shell disks made from Olivella biplicata. An arrow-head was found with another skeleton. About three feet from the excavation described, I found three more skeletons, one of which was that of a child; and with it occurred two stone tubes similar to those above mentioned, also three round beads about one inch in diameter. The beads and tubes were of serpentine, containing seams of chrysolite, and were finely polished. With another skeleton, were five arrow-heads finely chipped from chert. One was a beautiful specimen with serrated edges, and a portion of the asphaltum with which it was fastened into the arrow still remained. With another, occurred several ornaments manufactured from Lucapina crenulata, and also an arrow-head. In a spot occupying less than fifteen feet in diameter I exhumed forty skeletons, piled one upon another. They were buried face downward, and could be counted only by the skulls. STEPHEN BOWERS.

San Buenaventura, Cal.

The spirifers of the upper Devonian.

In the prefatory letter of the Report of progress, G. 7, of the Second geological survey of Pennsylvania, certain statements are made respecting the association and order of some of the fossil species of the Devonian rocks of New York, calling for comment.

It is stated on p. xx., in regard to Spirifera disjuncta, S. mesocostalis, and S. mesostrialis, that, "outside of Pennsylvania, these three species have been found, (1) never in any but Chemung rocks; (2) confined each to its own horizon; and (3) always in a fixed order from above downwards;" and, on p. xxi., that "Professor Hall has never seen any two of the three species co-existing in the same stratum; . . . that he cannot comprehend how S. dj. and S. ms. should be found together" (as they are reported to occur on p. 65 of the report).

Again (p. xxii.) it is stated that "Orthis tulliensis, in bed 41, § 13, p. 70, has certainly never before been seen in the Chemung 200′ above the Genesee (i.e., 300′ above the Tully limestone), nor in company of S. mesocostalis."

The report of species in such 'uncanonical' positions in the strata is made a reason for concluding (p. xxvi.) that "the startling fossil species of this report will therefore be regarded by the palaeontological reader as only *provisionally verified.*"

While the statements cited may express the general rule as to the occurrence of species in New-York state, there are specimens in Cornell university museum which do not bear out the statements.

In the first place, the two species S. mesostrialis and S. mesocostalis are found associated in the same stratum at Ithaca, N.Y., both in the mesostrialis zone and in the mesocostalis zone. Several instances can be shown where they occur on the same slab.

From a higher horizon in New-York state, and from several localities, either of these species may be found associated with S. disjuncta; and I have obtained each of the three species from the original Chemung locality at Chemung Narrows.

In the museum collection, is a small slab from that locality, containing beautiful representatives of S. disjuncta and S. mesostrialis; the latter preserving 'the fine radiate striae, with delicate concentric cross-lines' all over the surface of the shell, and with 'the broad median fold without a depression,' which are described as distinctive characters of the species (Pal. N.Y., vol. 4, p. 243).

The other specimen, only a couple of inches distant, has the characteristic plications on the median fold, and, with a surface equally well preserved, shows not the least trace of radiate or concentric striae, unmistakably indicating S. disjuncta.

From the same locality, though not on this individual slab, are specimens of both varieties of the so-called S. mesocostalis, — the large, coarse form with angular plications and reduplicated fold, and the more finely plicated form with prolonged hinge-line, which is more characteristic of a lower horizon.

These higher representatives of S. mesocostalis are, however, generally distinguished from the earlier representatives by a well-developed median septum in the ventral valve, — a character of which only a trace is seen in specimens from the Ithaca beds, reminding us of the genus Spiriferina. The punctate shell-structure of that genus has not, however, been detected in any specimens thus far examined.

In regard to Orthis tulliensis, it may be said that the common Orthis, occurring at the base of the Ithaca fauna, within a few hundred feet of the Genesee shale (less than 500), at its first appearance resembles O. tulliensis in form and general characters; though for distinction it may be appropriate to call it a variety of O. impressa, since a little higher, and in the same fauna, the typical O. impressa appears in abundance.

Still, there are specimens in the collection from the lowest zone which it would be difficult for any one to distinguish, by macroscopic or microscopic characters, from O. tulliensis, occurring, as they do, in a calcareous stratum.

I have no single slab containing this form with S. mesocostalis, but the latter is found both above and below the stratum containing the Orthis.

The record of an O. tulliensis at 200 feet above the Genesee shale in Pennsylvania seems, therefore, indicative of a careful identification of the species upon morphologic characters alone, without prejudice as to its supposed horizon or range.

In regard to the identification of these upper Devonian faunas of Columbia county, Penn., it may be said, that in the association of species, and the

relative order of the sub-faunas, the record agrees, in general, with that of the series exposed along the same meridian, farther north, in New-York state. The principal difference which strikes one familiar with the New-York section is the appearance of S. disjuncta and O. Tioga lower down in the faunas in the southern sections.

But although heretofore S. disjuncta has been met with in America only in the middle and upper parts of the upper Devonian, in Devonshire we find it reported from the middle Devonian, with corals and trilobites in abundance; and in northern Europe it begins at least as early as the base of the upper Devonian.

While it is beyond doubt that even in New-York state the three spirifers mentioned appear mingled at various zones in the upper Devonian, we do not question the fact that the periods of abundance for each species are in separate zones, and assume a regular sequence relative to each other.

HENRY S. WILLIAMS.

Cornell university.

The use of the method of limits in mathematical teaching.

Rice and Johnson's 'Method of rates' is especially to be commended for the scholarly manner in which they developed the subject; but there is the same difficulty in the fundamental conception as in the infinitesimal method. One may assume to understand an expression with which he is familiar until closely questioned. A student learns to repeat with ease, 'Velocity is rate of motion,' and thinks he understands it; but I have had many such ask, 'In a mathematically perfect engine, does the piston stop at the end of the stroke?' 'Does it remain at rest at any time?' 'How can it reverse its motion, if it does not stop?' 'How can it cease going in one direction, and move in the opposite direction, without stopping between the two motions?' These are critical questions, lying at the very foundation of all change of motion. Does change in the rate of motion take place *at* an instant, or *during* an instant?

The method of limits leads the mind towards a result the conclusions of which it is impossible to escape: hence, as a system of philosophy, it retains its strong hold.

DE VOLSON WOOD.

Hoboken, March 16.

Ropes of ice.

On Saturday, March 8, while traversing several counties of southern Ohio by railroad, I observed an illustration of the viscosity of ice, that seems deserving of mention.

For a number of hours, rain had been falling, much of it freezing as it fell; but through the day the temperature rose slightly, remaining, however, close to the freezing-point. All exposed objects were coated with ice. In particular, telegraph-wires and the strands of wire fences were heavily loaded. In the afternoon the ice broke loose from the wires at innumerable points, hanging from them in depending curves, the fixed points of which were sometimes as much as six or eight feet apart, and the lowest points of the curves from two to twelve inches below the wires. Occasionally the curves would break, and the ends of the ice rope, two or three feet in length, would project downwards from the wires at an angle of forty-five degrees or more.

The best examples were passed without opportunity to make examination, but all of the facts were illustrated at the stations where the train stopped.

E. O.

Illusive memory.

I merely intended, in my letter of March 7, to present two of the most prevalent theories which have been advanced for these illusions. The 'race memory' theory, kindly brought out by W. B. T., should perhaps have been mentioned, as well as the theory of Lewes and Ribot, that these deceptions arise from the retrojection or false location of a *present* mental image as a recollection. The inheritance of the actual *cerebral impressions* of a former generation rests upon no scientific basis. We do inherit the brain structure, and, in so far as brain functions are dependent upon structure, we may be said to inherit certain functional disposition and powers; but this structure, and the impressions made upon it by sense-perception, are essentially different facts.

The correspondence invited should be addressed to Princeton, *N.J.*, instead of Princeton, N.Y., as as wrongly given in *Science*, No. 57.

HENRY F. OSBORN.

Princeton, N.J., March 21.

Ripple-marks.

Professor Wooster's note in No. 57, on ripple-marked limestones in Kansas, recalls an observation of my own in Utah. In the south part of that territory the Jurassic formation includes a sectile limestone fifteen to twenty-five feet in thickness, containing remains of Camptonectes and Pentacrinus. Some of the surfaces of the layers exhibit coarse ripple-marks, the wave-lengths ranging from six inches to one foot. The associated fossils cannot be regarded in this case as indicative of quiet conditions, for in neighboring districts the same forms are found in argillaceous sandstones. In the sandstones the shells and crinoid segments exhibit wear from rolling, but in the limestone their angles are unimpaired. While, however, there is no evidence in the limestone of violence, there is evidence of motion. The crinoids have not been found entire, and all their segments are usually detached. Moreover, the structure of some of the limestone layers is oölitic.

I conceive that the association of ripple-marks with shallow water, while usual, is not invariable. The most important condition for the formation of ripple-marks is motion; and any thing competent to produce motion at the bottom of deep water may form them. Wind-waves on the Atlantic are said to have brought sand to the surface from a depth of five hundred feet, and they must be supposed to produce at a still greater depth the gentler agitation necessary for the formation of ripple-marks.

The association of the Kansas ripple-marks with fine argillaceous rocks is perhaps unprecedented, but there seems no theoretic reason to regard it with wonder. Fine sediment does not usually come to rest in spots where the water is subject to agitation, but exceptionally it does; and the centre of every shallow pond with a muddy bottom affords an illustration. Some years ago I observed ripple-marks on a surface of fine river-silt at the bottom of a pool which had communication with a rushing river. The pulsation of the torrent communicated agitation to the pool, but no current; and I inferred that the pulsatory agitation caused the rippling. The pool shared to some extent the muddiness of the river, and the silt on its bottom was evidently a forming deposit. Not far away the bank of the same river exhibited in section